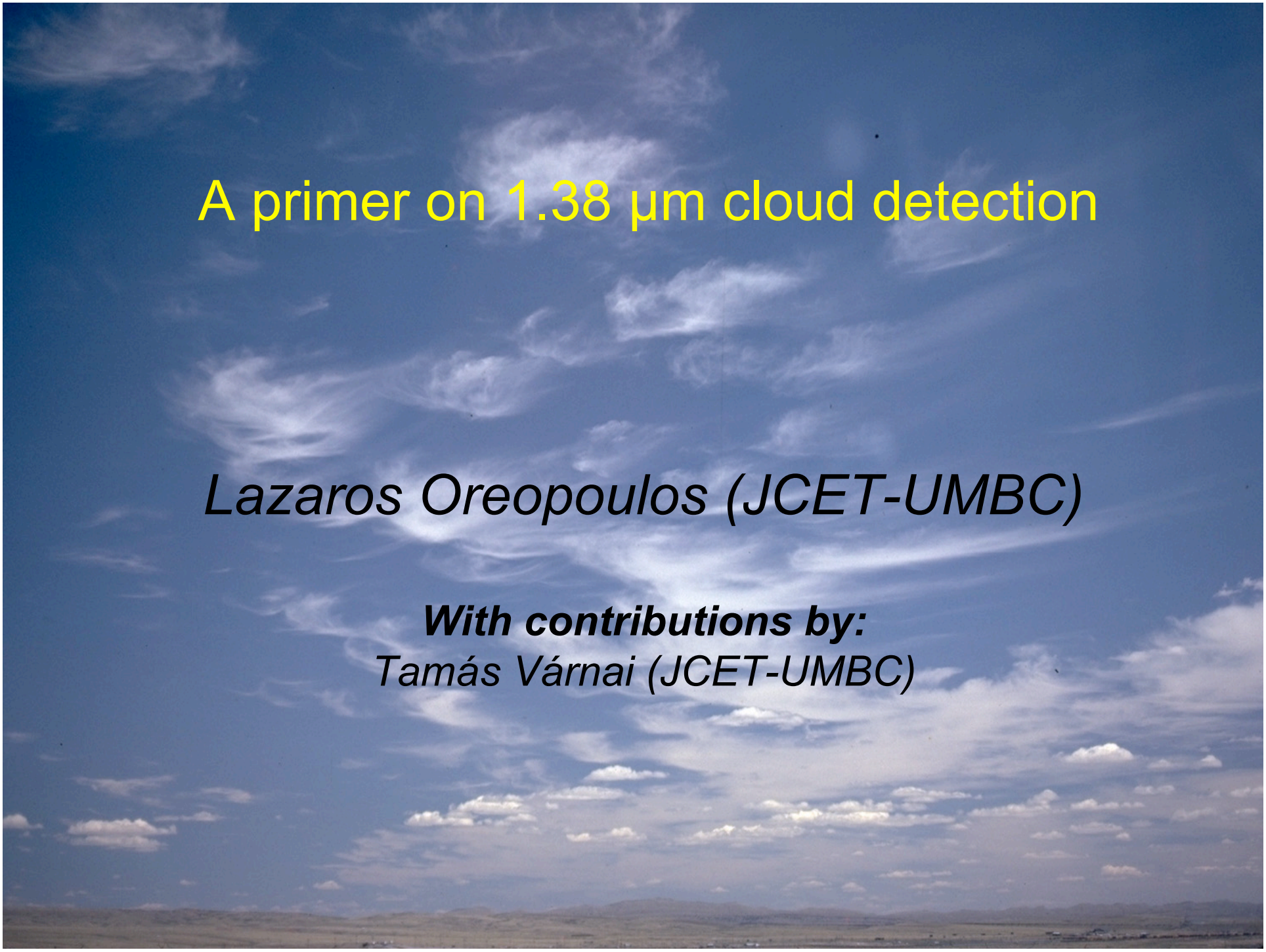
A primer on 1.38 μm cloud detection
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With contributions by:
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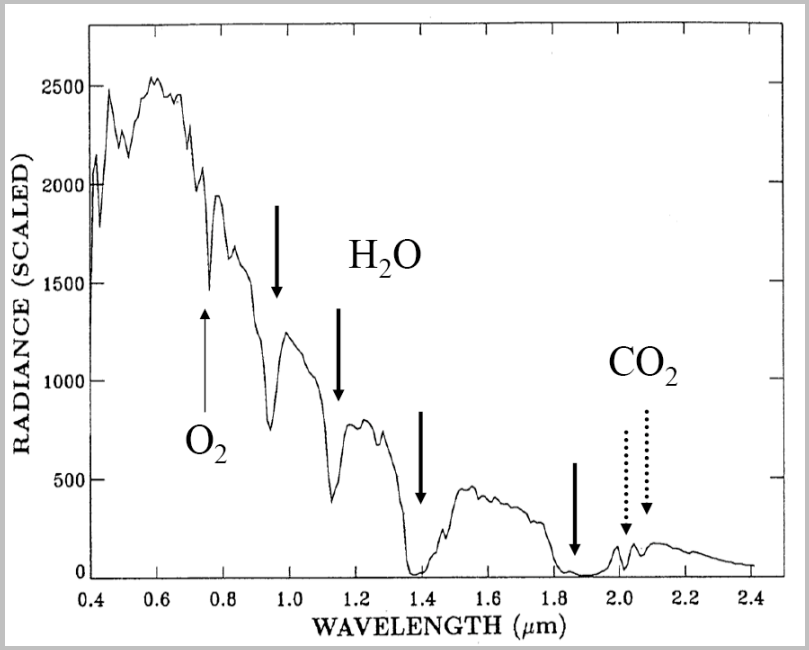
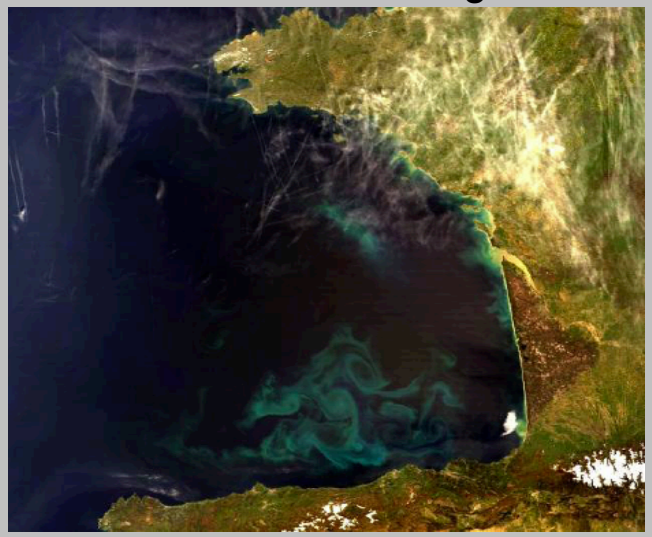
Principles of 1.38 μm cloud detection

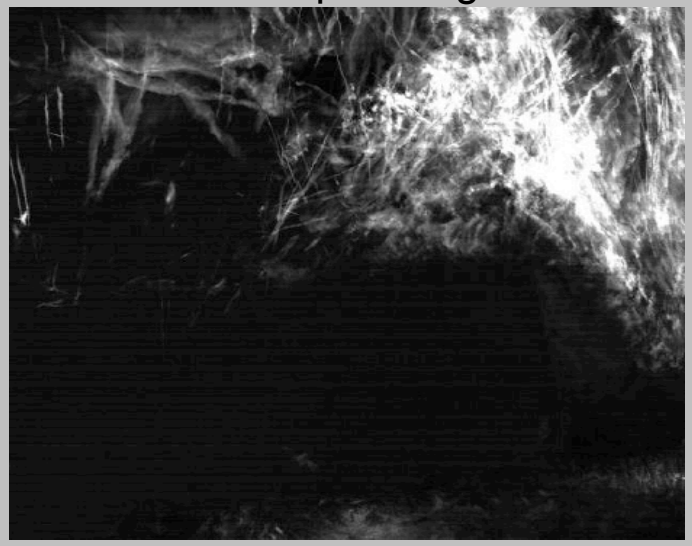


- Strong water vapor absorption band at 1.38 μm
- With no high clouds, radiation scattered from surface and low clouds is absorbed by water vapor (surface and low clouds form a dark background)
- With high clouds present, 1.38 μm radiation scattered by them reaches the sensor because there is not enough water vapor above to extinguish the signal
- High clouds stand out in 1.38 μm imagery against the dark background

MODIS RGB image

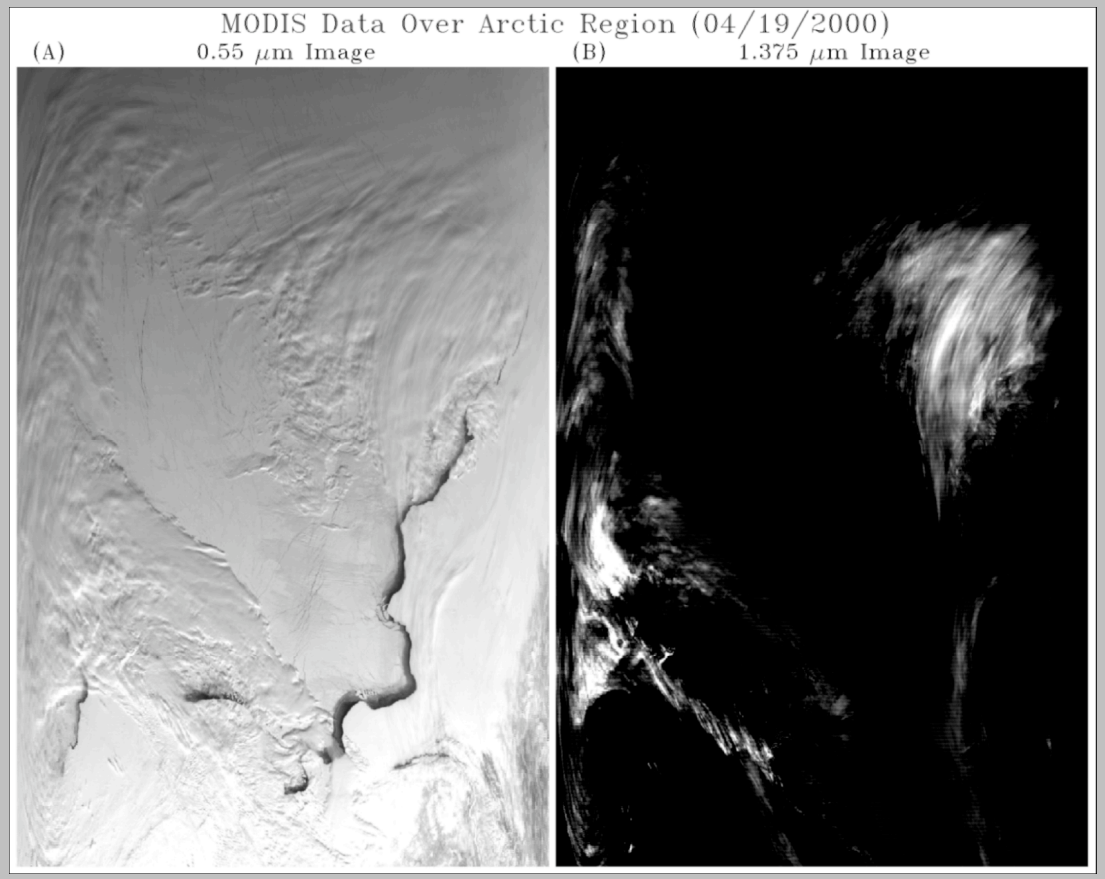


1.38 μm image



Caveats

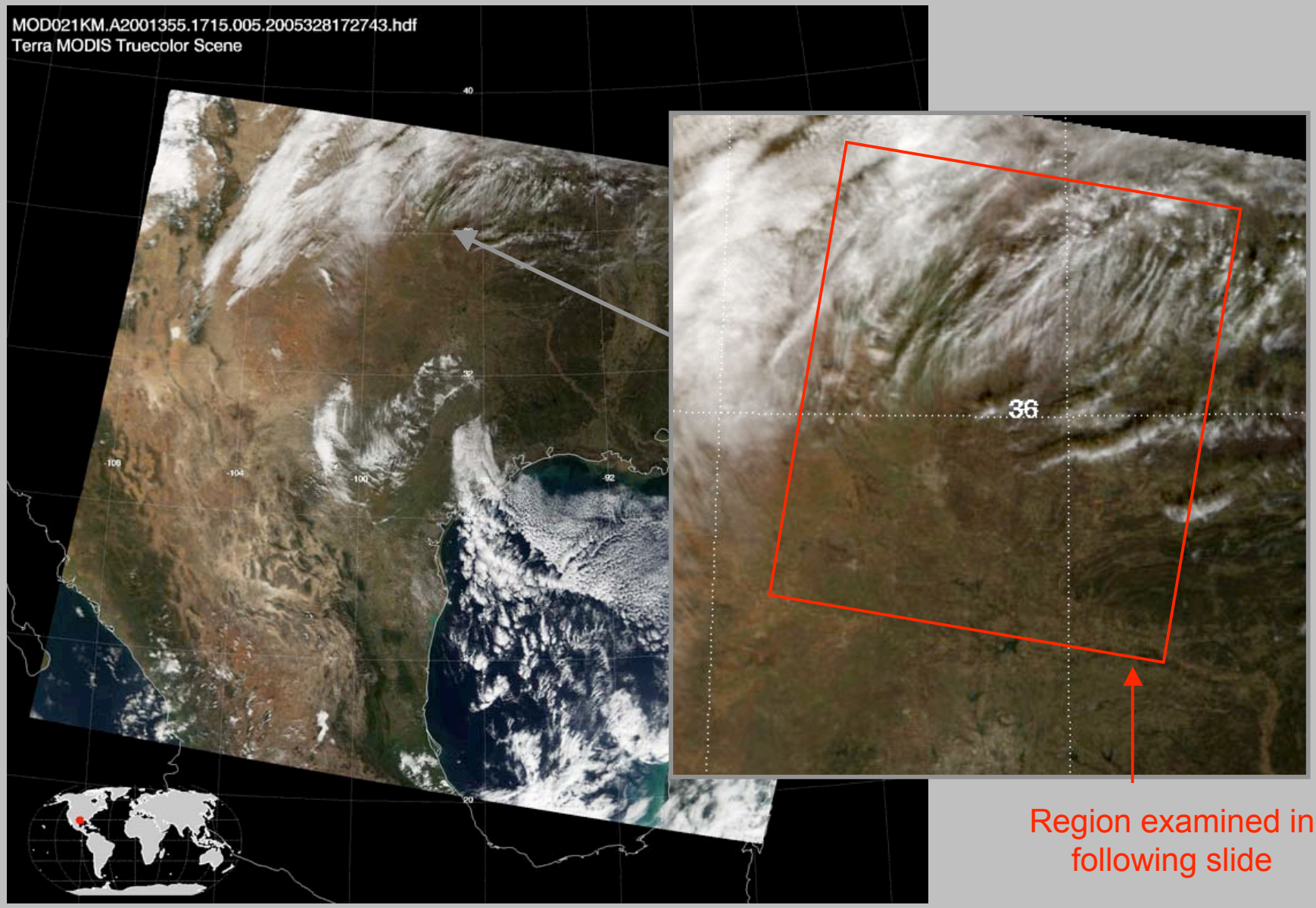
- Does not work when atmosphere is dry, < 0.4 cm precipitable water and surface albedo high (deserts, polar regions, high altitude regions)
- *This is mainly a high cloud detection method, and picking up the thin cirrus only is considerably more tricky*



(From Gao et al., TGRS, 2003)

Works in polar regions only with sufficient water vapor and when surface is not too reflective (e.g., does not work for fresh snow)

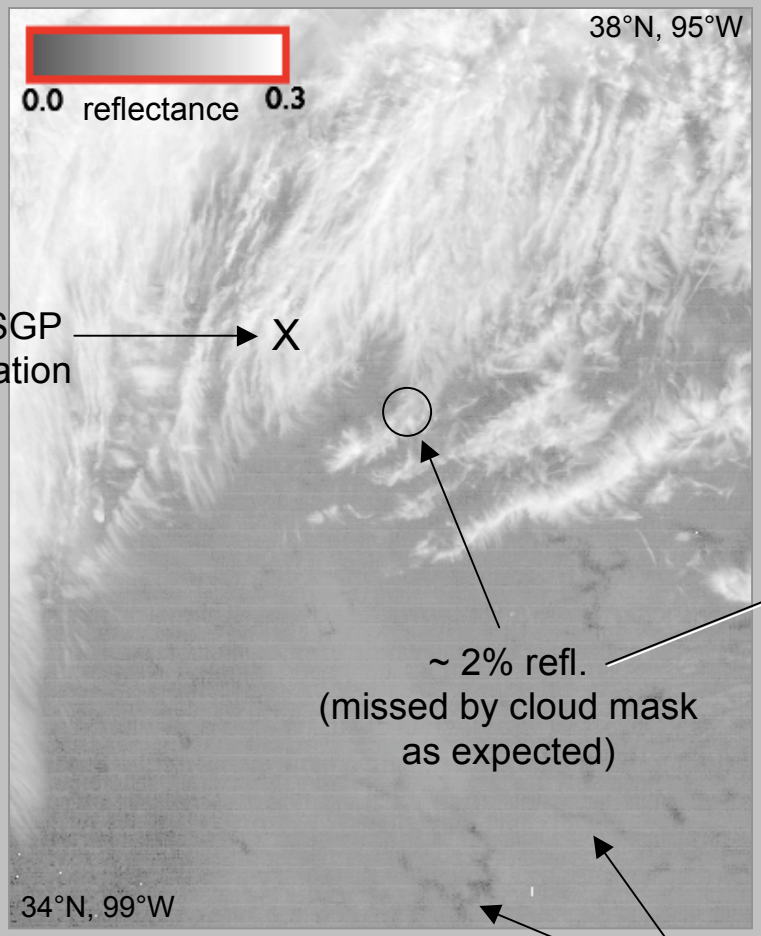
False cirrus detections



Courtesy of Steve Platnick, NASA/GSFC

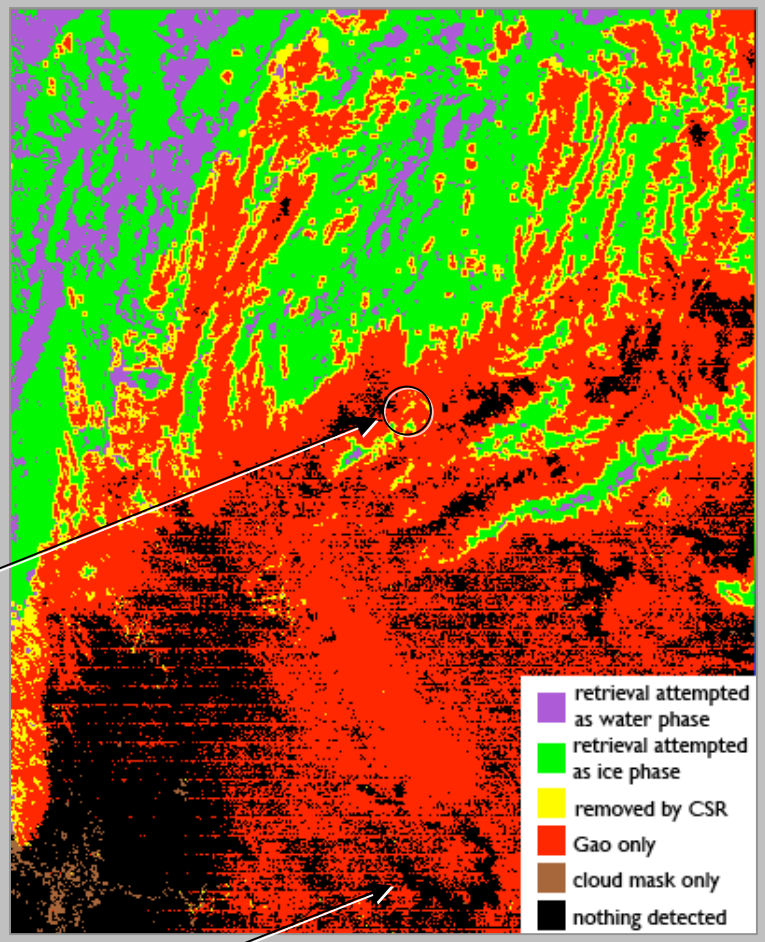
Cirrus_Reflectance

(B.-C. Gao product in MOD06, represents 0.65 μm band reflectance inferred from 1.38 μm observations)



Various Scene Masks

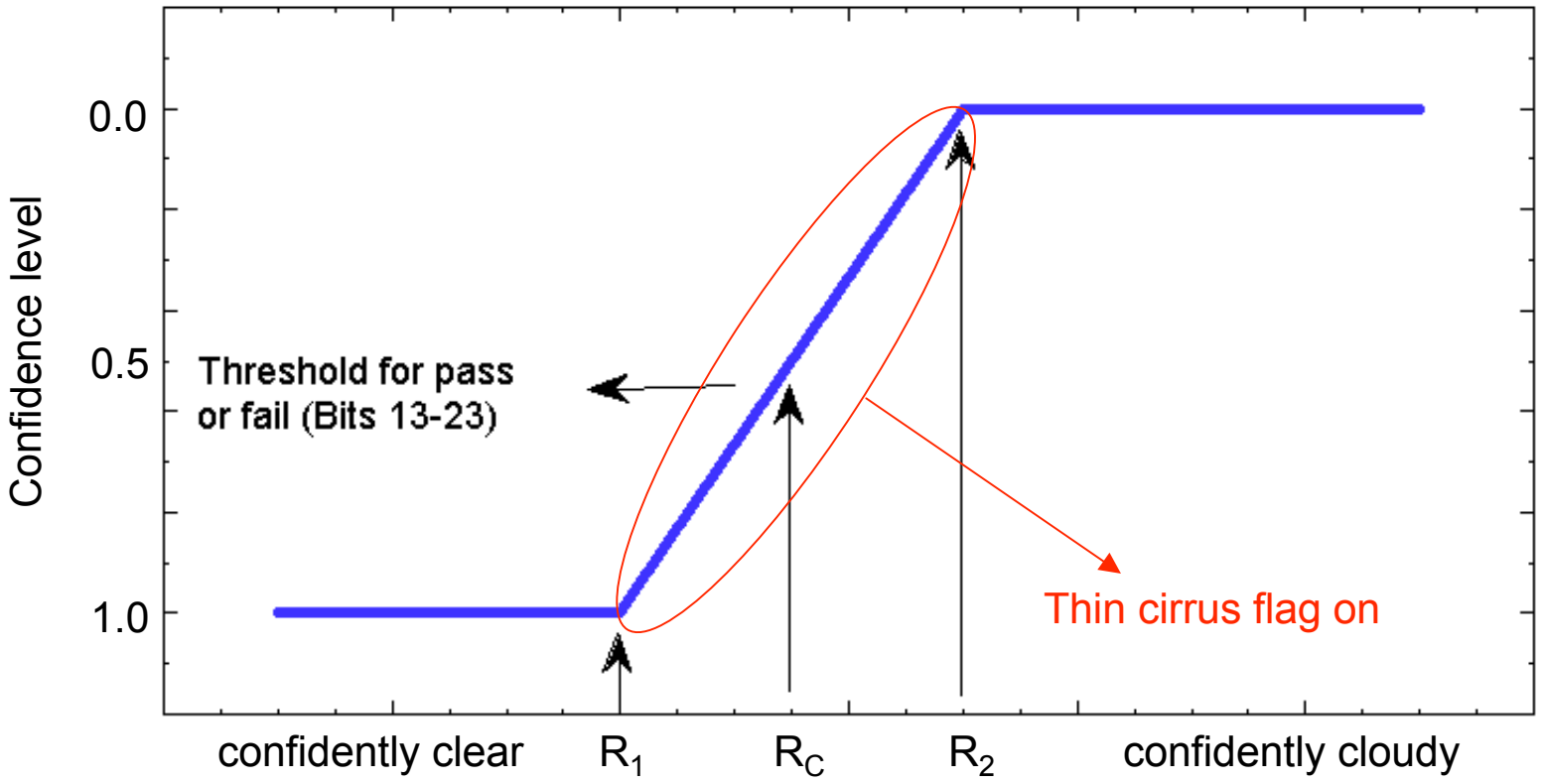
(cloud mask detection represented by all colors but red and black, see notes for details)



surface features surrounded by false “cirrus” detection

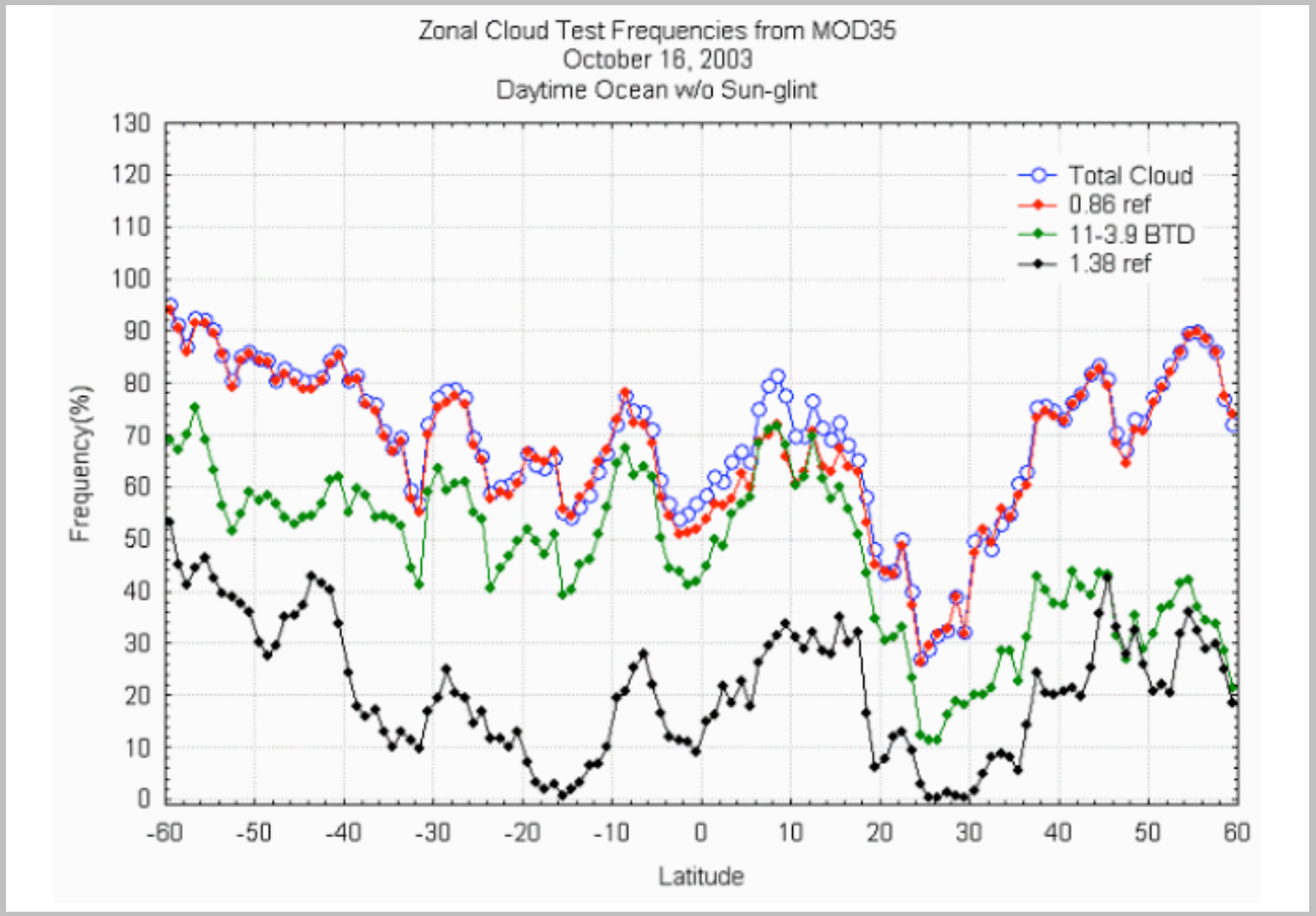
Courtesy of Steve Platnick, NASA/GSFC

MODIS cloud detection philosophy



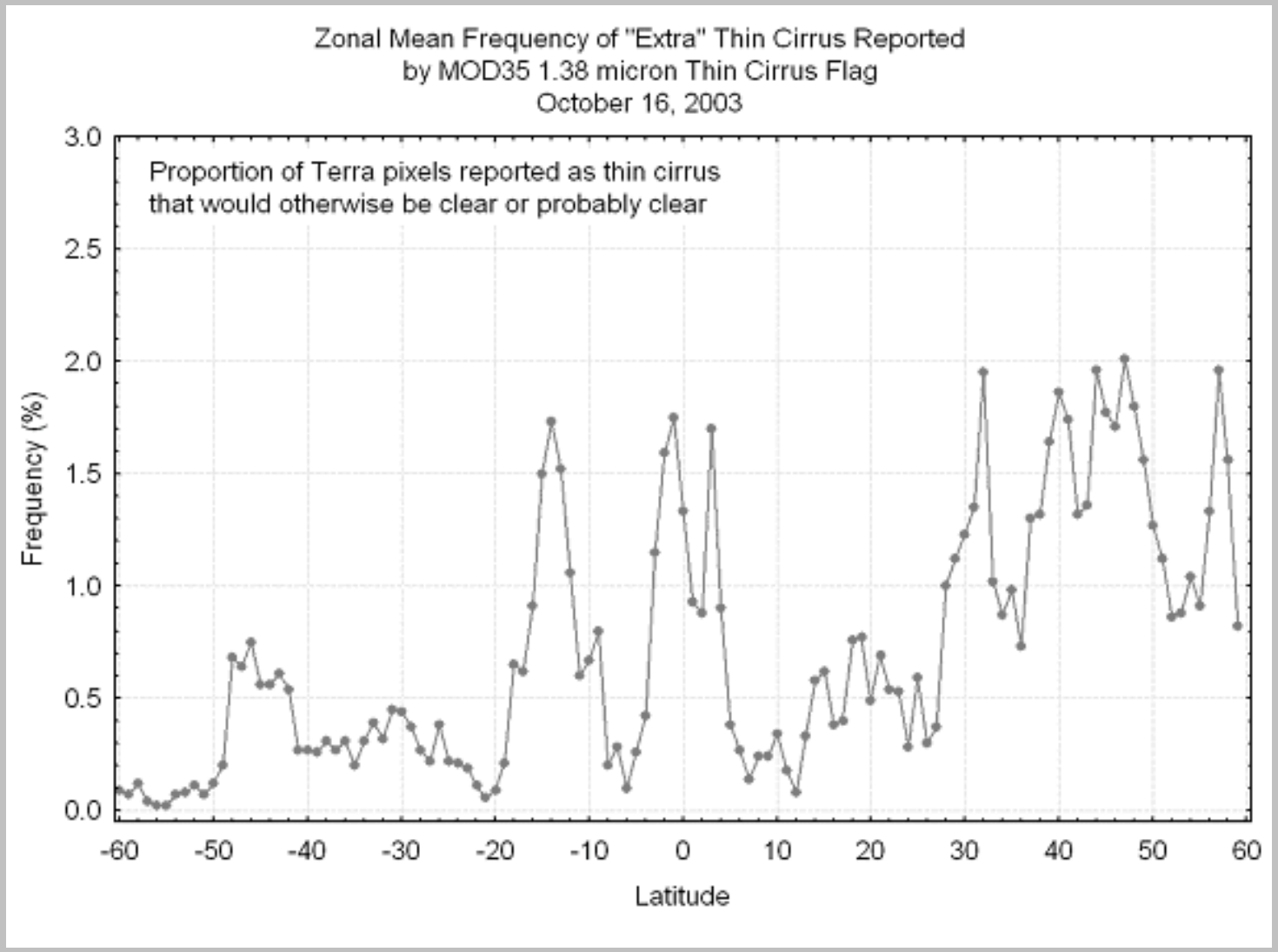
	$R_1^{1.38}$	$R_C^{1.38}$	$R_2^{1.38}$
non-snow/ice	0.030	0.035	0.040
snow-ice	0.0450	0.0525	0.0600

MODIS 1.38 μm high clouds over ocean



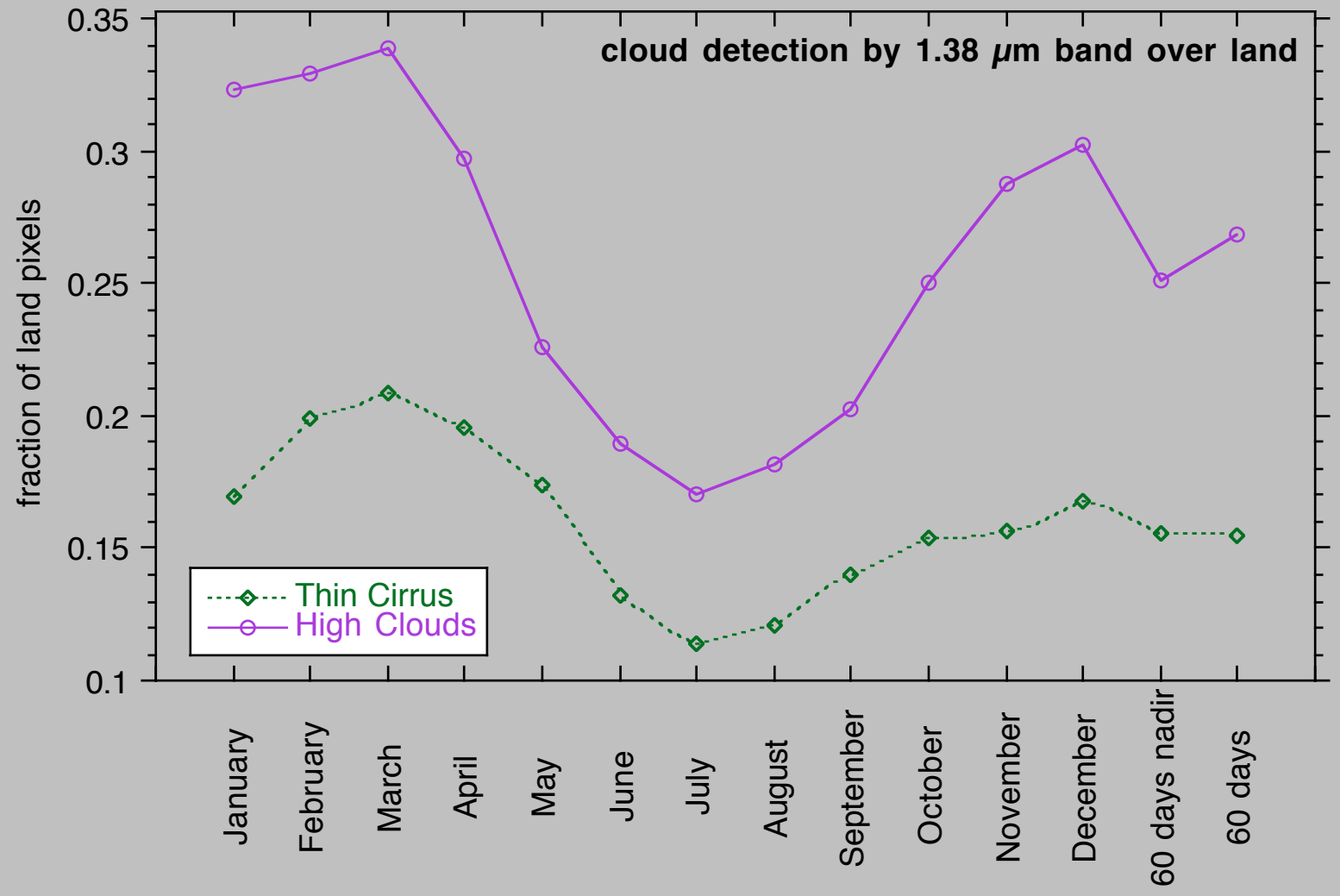
Zonal mean frequencies of cloudy conditions for October 16, 2003, daytime ocean scenes as a function of three threshold cloud detection tests and the combination of all 16 tests from MODIS (from Ackerman et al. JAOTECH, in press).

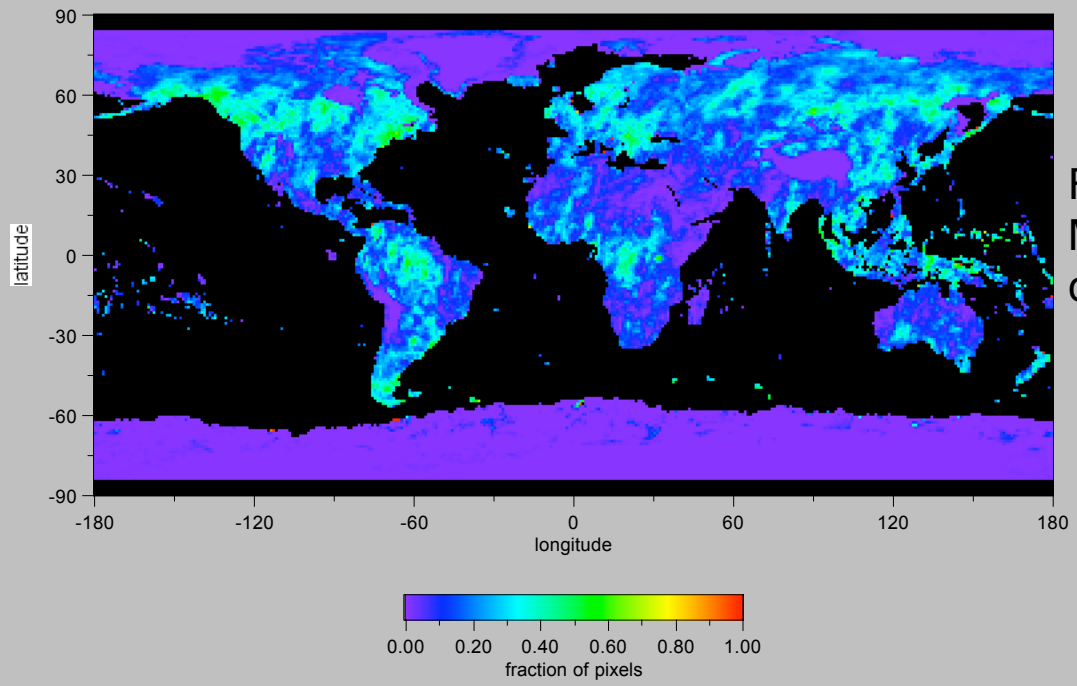
Thin cirrus MODIS analysis



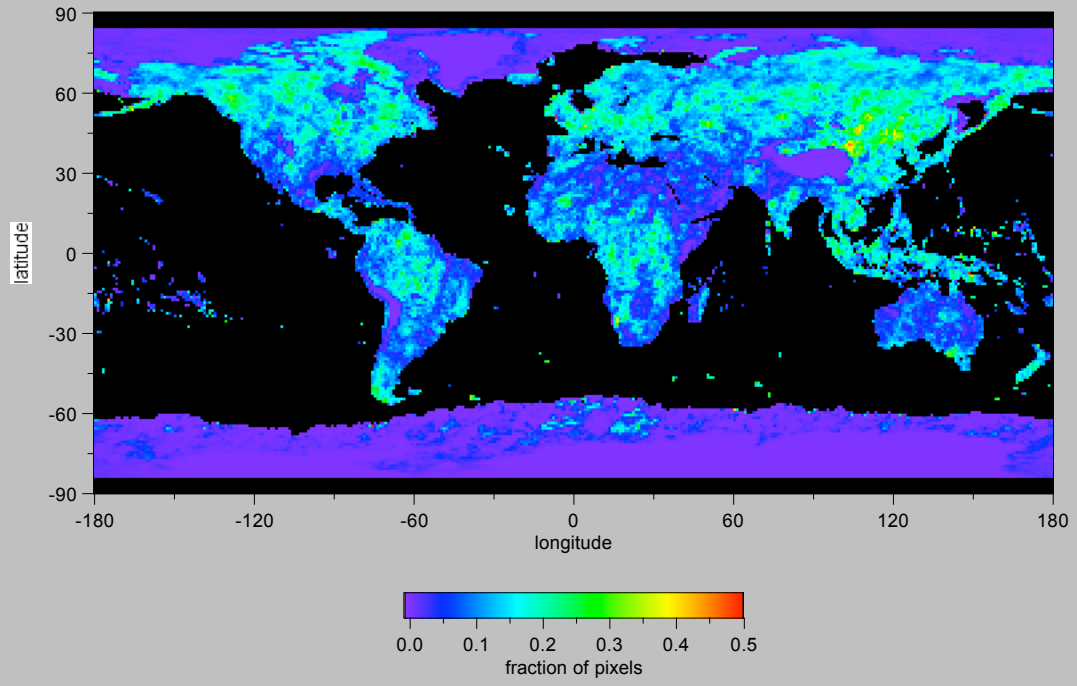
Additional zonal mean cloud fraction due to thin cirrus using the 1.38 micron channel of Terra MODIS. Other tests in the algorithm indicate the pixel to be clear or probably clear (from Ackerman et al. JAOTECH, in press)

Our own global results from MODIS (2005)

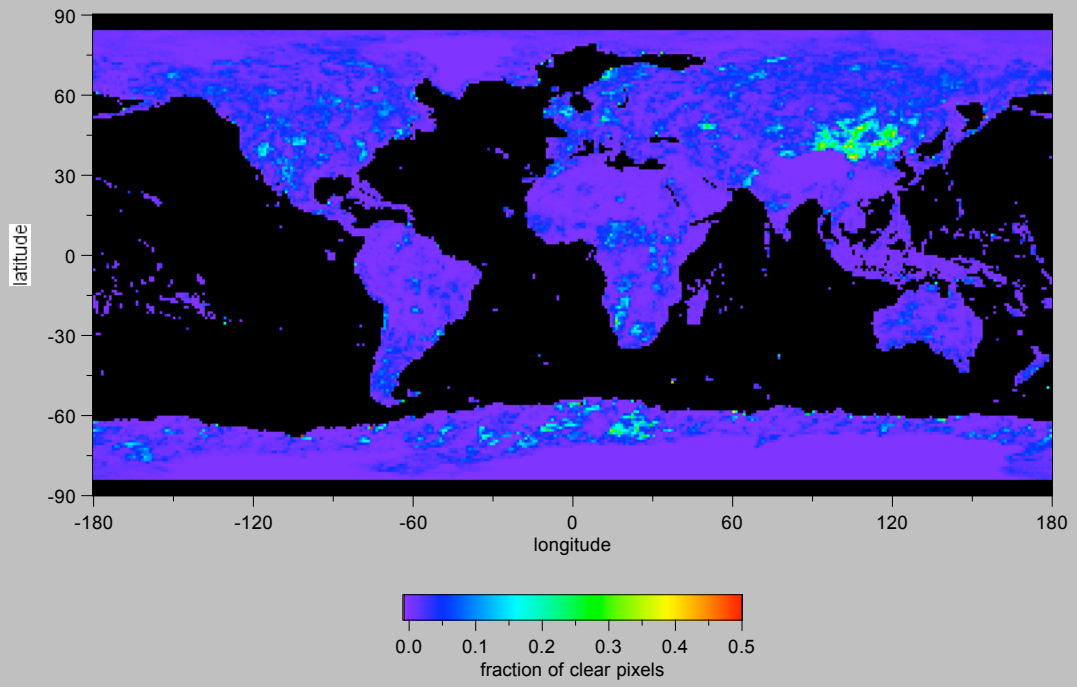




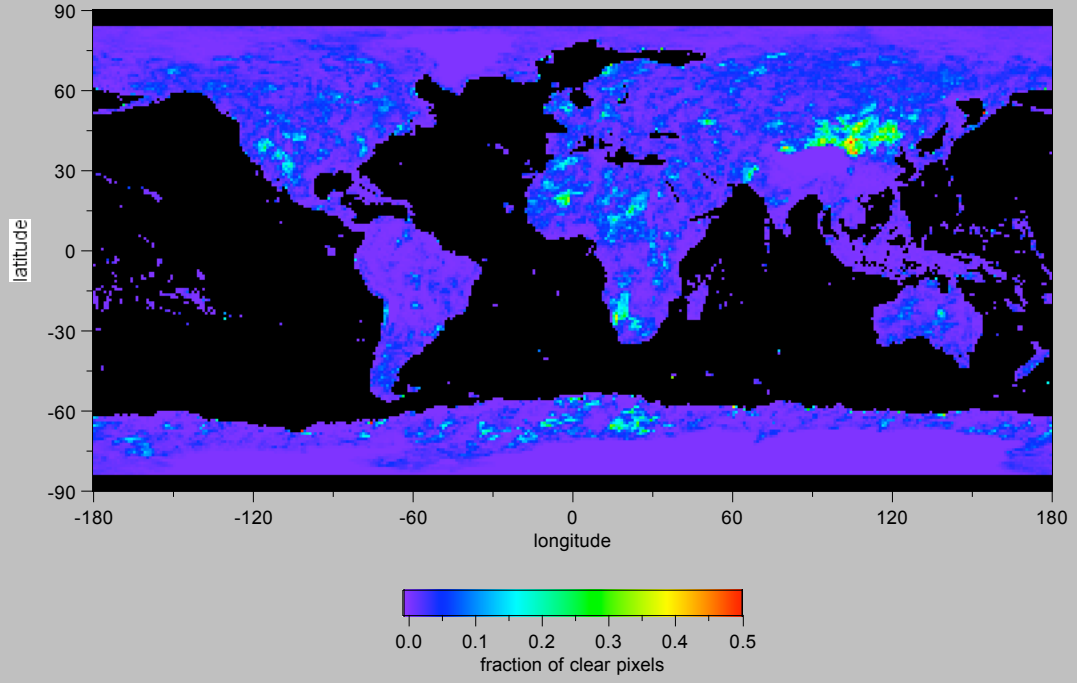
Fraction of pixels for which the 1.38 μm MODIS *high cloud* spectral test indicates cloud presence



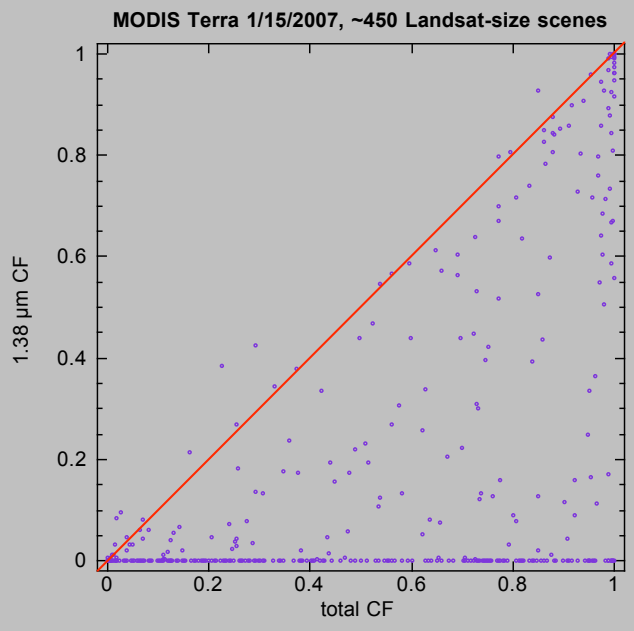
Fraction of pixels for which the 1.38 μm MODIS *thin cirrus* spectral test indicates cloud presence

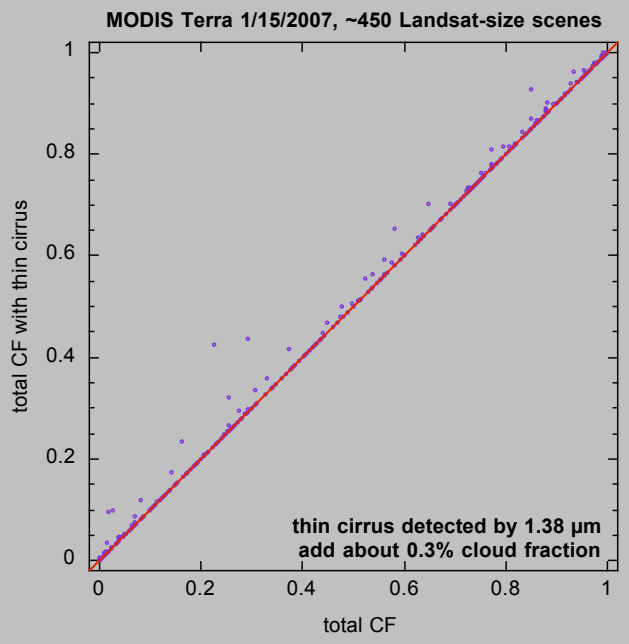


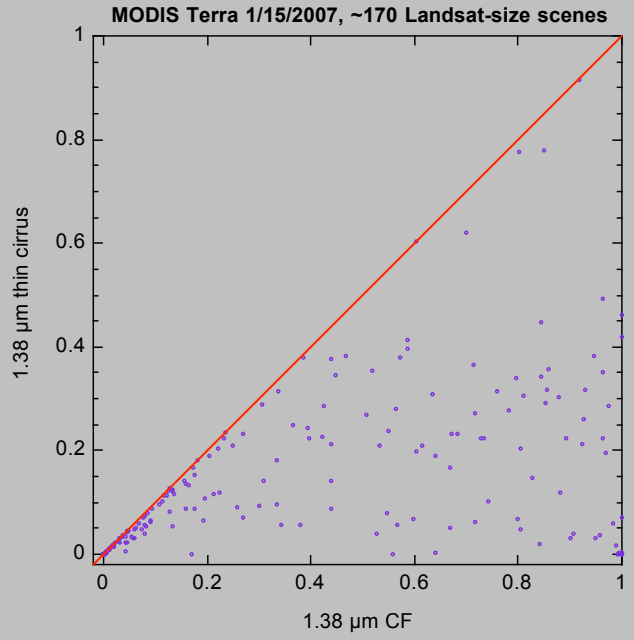
Fraction of clear pixels for which the 1.38 μm MODIS *thin cirrus* spectral test indicates cloud presence while the full MODIS cloud mask indicates clear skies

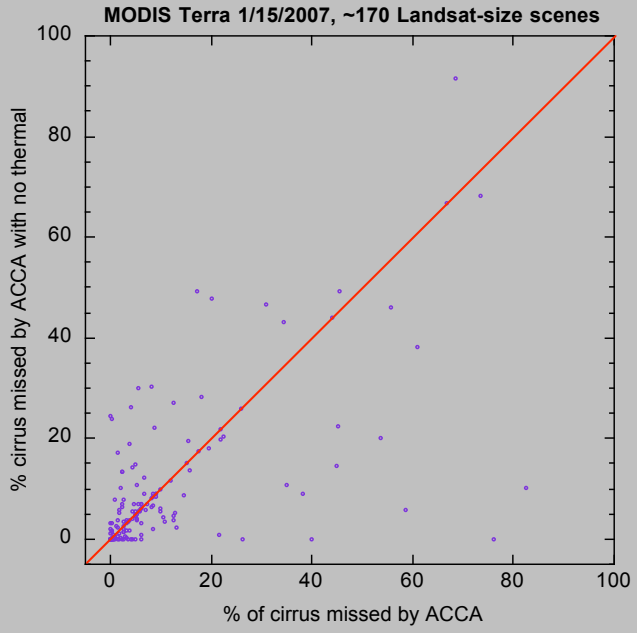


Fraction of clear pixels for which the 1.38 μm MODIS *thin cirrus or high cloud* spectral tests indicate cloud presence while the full MODIS cloud mask indicates clear skies


MODIS Terra 1/15/2007, ~450 Landsat-size scenes
1.38 µm CF
total CF
0
0.2
0.4
0.6
0.8
1


MODIS Terra 1/15/2007, ~450 Landsat-size scenes
total CF with thin cirrus
total CF
thin cirrus detected by 1.38 µm
add about 0.3% cloud fraction
0
0.2
0.4
0.6
0.8
1


MODIS Terra 1/15/2007, ~170 Landsat-size scenes
1.38 µm thin cirrus
1.38 µm CF
0
0.2
0.4
0.6
0.8
1

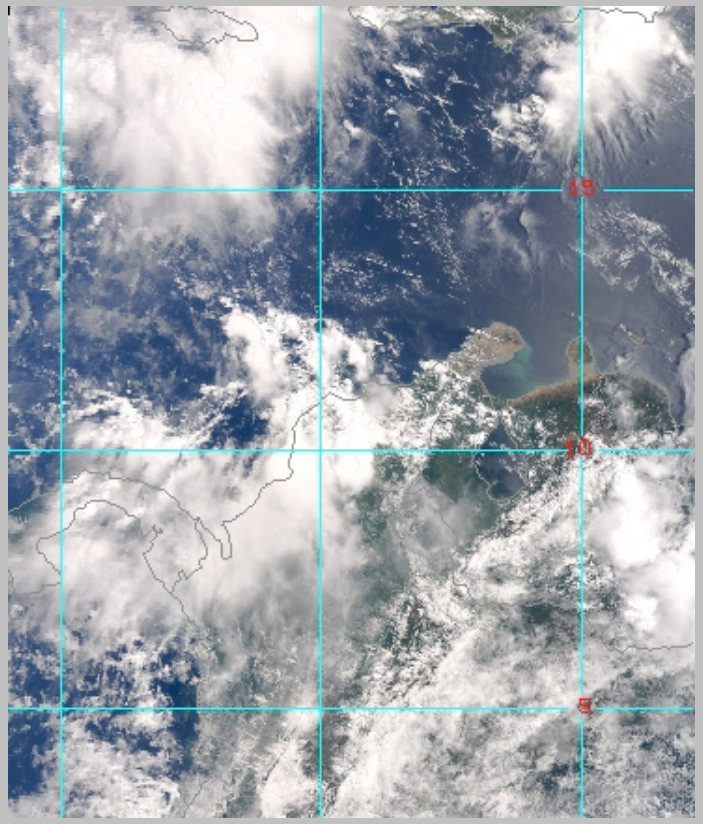

MODIS Terra 1/15/2007, ~170 Landsat-size scenes
% cirrus missed by ACCA with no thermal
% of cirrus missed by ACCA
0
20
40
60
80
100

Some thoughts on LDCM 1.38 µm

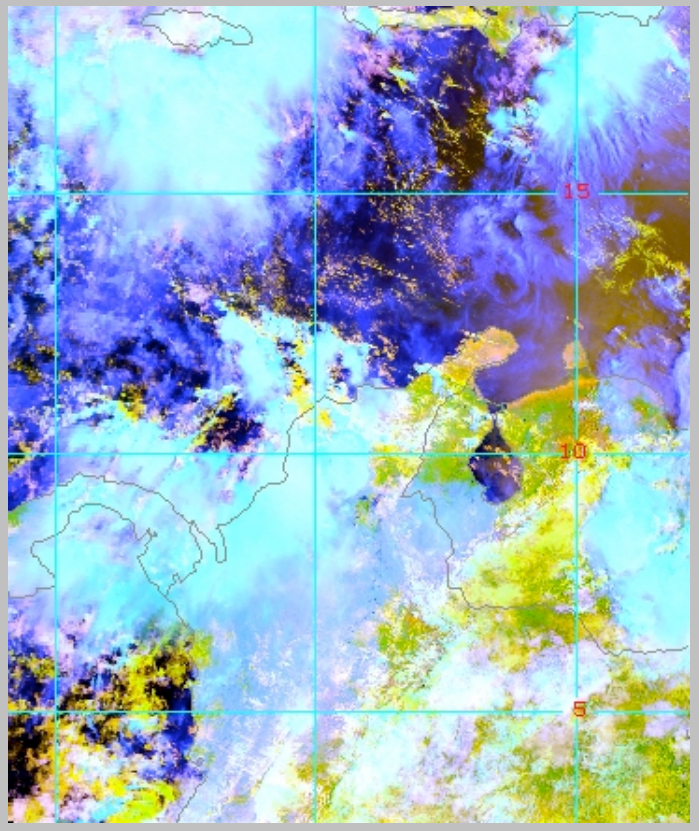
- How will the 1.38 µm band be used in LDCM?
  - Part of the cloud mask algorithm? Separate mask?
  - Separate thin from thick high clouds?
  - Provide imagery in the ordering system?
- Quantitative use is difficult
  - Thresholds for cloud masking depend on SZA and surface type
  - Isolate cirrus reflectance for scene correction
  - Need cirrus reflectance in remaining bands
  - Experience with MODIS, but spatial resolution is different
  - Radiative transfer modeling is needed

Picking thin cirrus in color composites

RGB = 0.67, 0.55, 0.46 μm



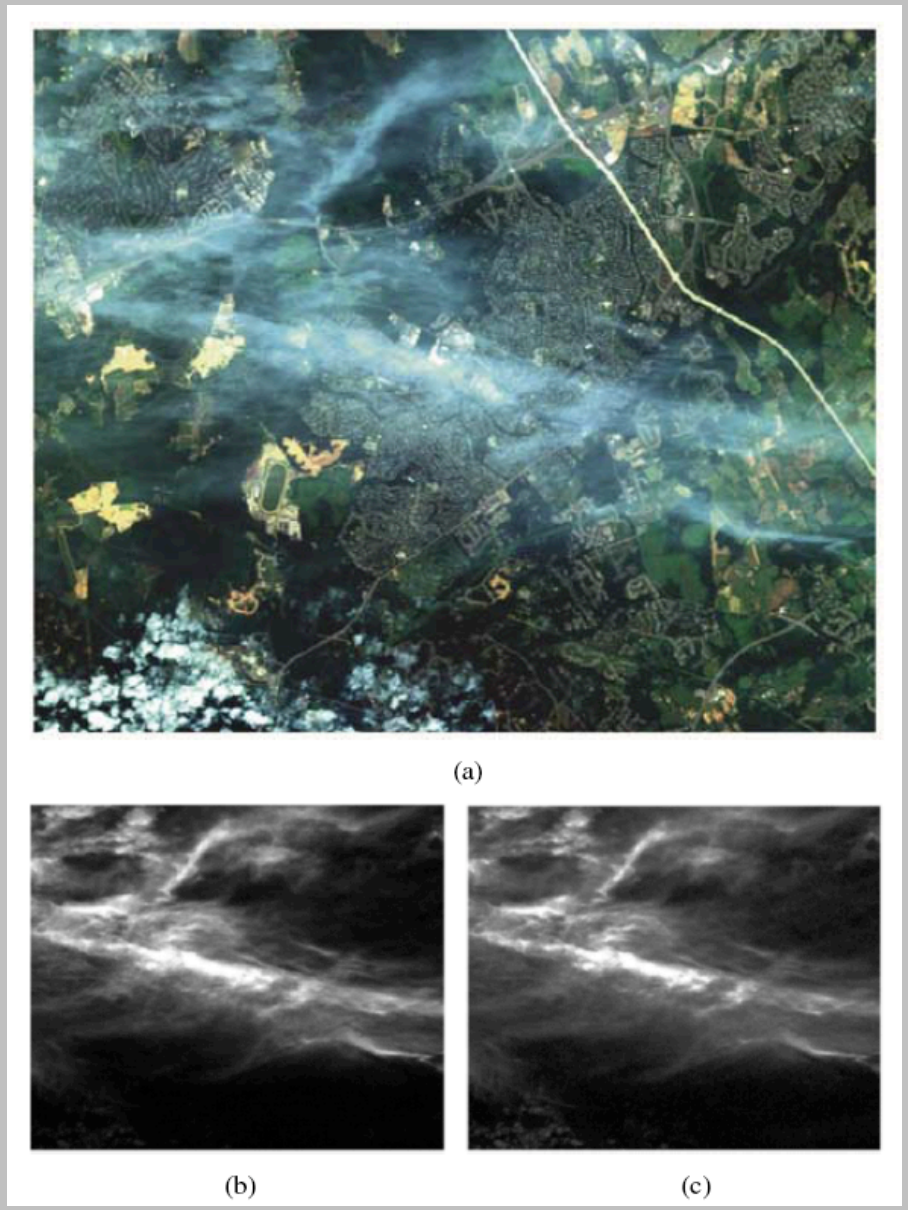
RGB = 1.6, 0.87, 1.38 μm



Blue indicates thin cirrus, Aqua indicates ice, Yellow indicates low liquid water clouds, White indicates higher water clouds.

Courtesy of Steve Platnick, NASA/GSFC

1.38 μm vs. true color RGB images



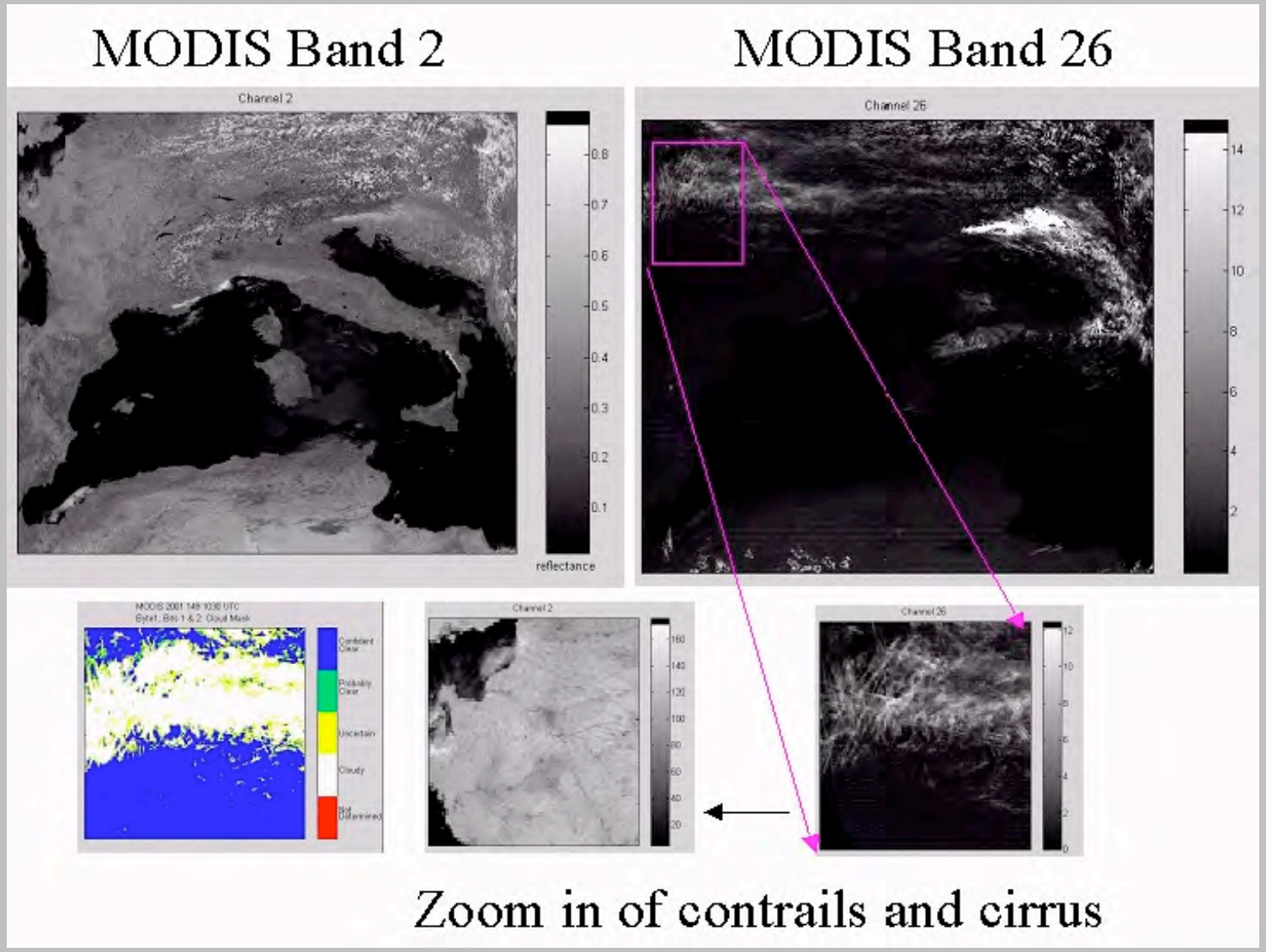
true color

1.38 μm

1.88 μm

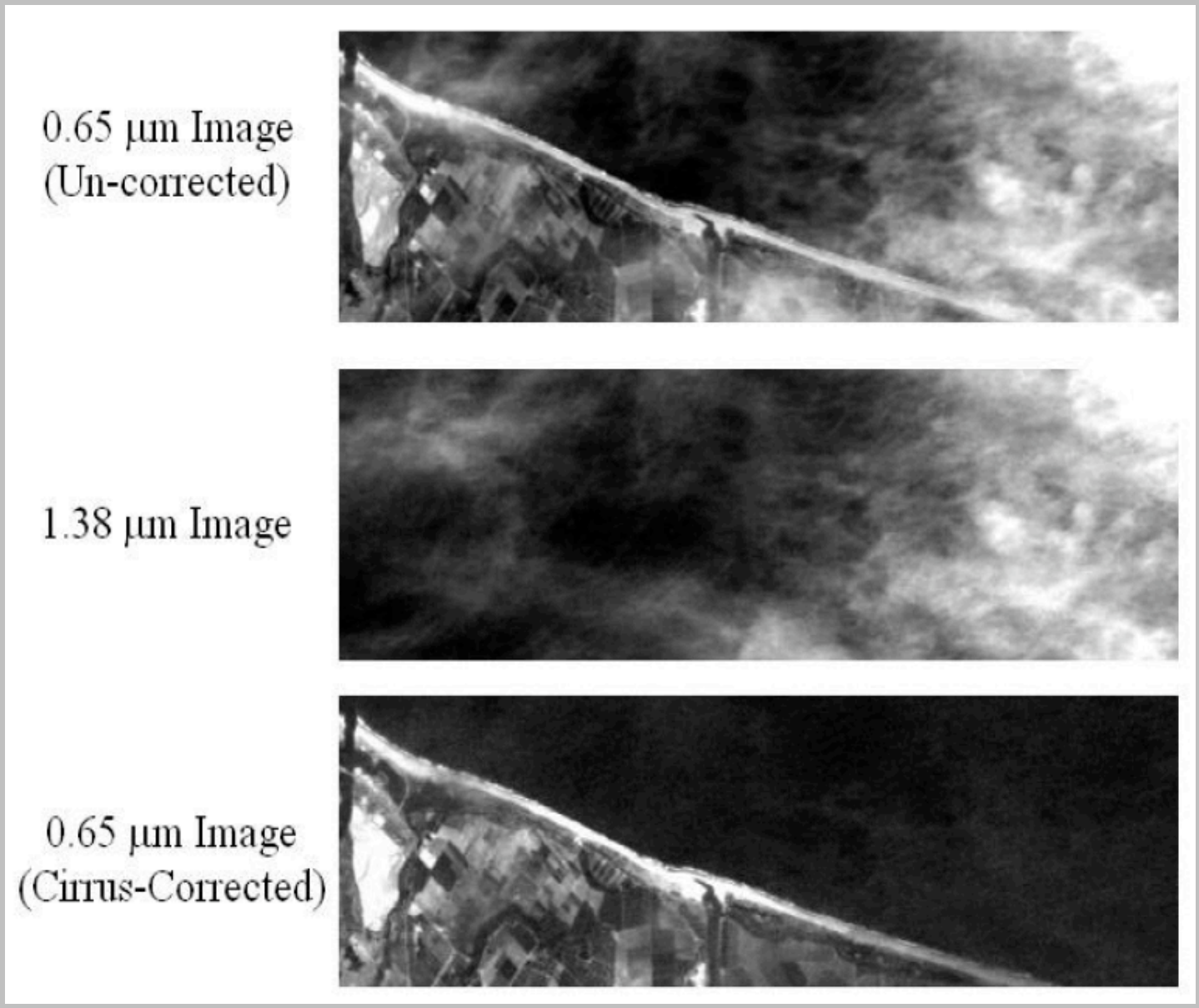
(from a Gao et al. TGRS, 2004)

1.38 μm vs. visible images



(from MODIS cloud mask ATBD)

Removing cirrus (image correction)



(from a Gao et al. presentation)